A Rapid Assessment of Sediment Delivery from Clearcut Timber Harvest Activities in the Battle Creek Watershed, Shasta and Tehama Counties, California
The Battle Creek Restoration Project
...benefiting fish and other wildlife

A. North Battle Creek Feeder Diversion Dam
   Replace fish ladder to improve adult fish passage; replace fish screen to prevent loss of juveniles; increase stream flow to improve habitat

B. Eagle Canyon Diversion Dam
   Replace fish ladder and fish screen; increase stream flow

C. Wildcat Diversion Dam, Pipeline, and Canal
   Remove dam, pipeline and canal

D. South Diversion Dam and Canal
   Remove dam and canal

E. Soap Creek Feeder Diversion Dam
   Remove dam

F. Inskip Diversion Dam and So. Powerhouse
   Replace fish ladder and fish screen; construct tunnel connector between South Power House and Inskip Canal; increase stream flow

G. Lower Ripley Creek Feeder Diversion Dam
   Remove dam

H. Coleman Diversion and Inskip Powerhouse
   Construct tailrace connector between Inskip Powerhouse and Coleman Canal; replace Inskip Powerhouse bypass; remove dam

I. Asbury Pump Station and Diversion Dam
   Increase stream flow; prevent fish passage above dam
SPI uses extensive clearcut harvesting.

Concerned environmental stakeholders in the watershed

(Sacramento Bee, 2011)
Troubled waters of Battle Creek

• Article implied clearcutting is causing water quality impacts to Battle Creek

• Permitting of clearcutting running counter to goals and objectives of Restoration Project

(Sacramento Bee, 2011)
TIMELINE

- **19th June, 2011** – Sacramento Bee article.

- **15th July, 2011** - Secretary Laird and staff meet with CAL FIRE, request timely interagency assessment of potential impacts.

- **1st September, 2011** – Battle Creek Task Force formed. Scoping begins.

- **21st thru 29th, September, 2011** – Field assessment over 5 days.

- **Early October to 4th November, 2011** – Analyses and report writing.
TIMELINE (continued)

• **9th November, 2011** – Presentation of findings to Board of Forestry

• **At request** – Presentation of findings to the Central Valley Regional Water Quality Control Board

• **At request** – Presentation of findings to the Fish and Game Commission
Battle Creek Task Force Formed

- Task Force staffed by two members from following THP Review Team agencies:
  - Central Valley Regional Water Quality Control Board;
  - California Department of Fish and Game;
  - California Geological Survey; and
  - CAL FIRE.

- Subject matter experts with decades of combined field experience in forestry-water-fish issues
Purpose Statement:
Evaluate whether timber operation associated with SPI clearcut harvesting in Battle Creek has resulted in observable erosion and subsequent delivery of sediment which has resulted in violation of state law or observable negative impacts to fisheries.
Background
Significant Water-Quality Impacts

= Significant Erosion + Significant Delivery to a Waterbody
Proximity of Erosion Source to Stream

(Croke and Hairsine, 2006)
Erosion Potential of Activity

Gully Erosion to a Class III watercourse
Soil Compaction

Bulk density (Mg m$^{-3}$)

Saturated hydraulic conductivity (mm/hr)

Less Overland Flow

More Overland Flow

Disturbed forest
Agriculture
Road surface and margins

(from Ziegler, 2005)
Surface Cover Removal

(Larsen and others, 2009)
Flowpath Modification

- Culverts can restrict flow of water
- Road and skid trails can collect, redistribute, and concentrate runoff
- Can increase erosion and risk of landsliding

Rilling on road surface
Soil/Earth Movement

Fill

Erosion
Potential Impacts from Overstory Removal

(Jones and Grant, 1996)
Hydrogeomorphic Context

- Young volcanics
- Relatively low drainage density
- Ground-water dominated hydrology
- Snow dominated, with rain-on-snow zone

(http://pubs.usgs.gov/fs/2000/fs022-00/images/erupt.jpg)
Land Use

- Mixture of land uses (timber harvest, grazing, recreation, rural residential);

- Mixture of county-maintained and privately-maintained roads.
Timber Harvest

- SPI owns 82 percent of Timber Production Zone lands in watershed
- ≈ 20,000 acres harvested using even-aged methods between 1997-2010
Site Selection – Clearcuts Adjacent to Watercourses
Site Selection - Road Crossings
Site Selection – Watercourse-Adjacent Road Segments

- Road segment
- Boulders in Place of Failed Fill Material
- Watercourse Bank
Site Selection - Tractor Crossings
Site Selection – Watercourse-Adjacent Landings
Site Selection

• Placed highest priority on clearcuts with buffers on fish-bearing streams (Class I WLPZs);
• Other prioritization criteria:
  – Time since operation (at least one season of overwintering)
  – Tractor logging
  – Steeper slopes
  – More erodible soils (e.g., rhyolite-derived soils)
Methods

• Walk the interface between clearcut and riparian buffer to look for sediment delivery (Litschert and MacDonald, 2009);

• Visit pre-identified road crossings, tractor crossings, and landings;

• Walk watercourse-adjacent road segments.
Methods

• Identify if sediment was delivered to watercourse;
• Evaluate relative magnitude of sediment delivery:
  – Low (< 1 yd$^3$)
  – Moderate (1 to 10 yd$^3$)
  – High (> 10 yd$^3$)
• Characterize erosion;
• Identify erosion source.
Was Sediment Delivered?

- **Clearcut units**: n=55
- **Road crossings**: n=39
- **Road segments**: n=24
- **Tractor crossings**: n=5
- **Landings**: n=6
- **Other**: n=3

Legend:
- **No**
- **Yes**
- **Maybe**
Clearcut units: n=55
Road crossings: n=39
Road segments: n=24
Tractor crossings: n=5
Landings: n=6
Other: n=3

Percent of Assessed Sites Delivering Sediment (%)

Sediment Source Association
Class I

Class II

Class III

Swale

Number of Watercourses Observed

Magnitude of Sediment Delivery:

- None
- Low
- Moderate
- High

Watercourse Classification
<table>
<thead>
<tr>
<th>Watercourse Classification</th>
<th>Total Length of Buffer (miles)</th>
<th>Length of Buffer Assessed (miles)</th>
<th>Percent Assessed</th>
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<tbody>
<tr>
<td>Class I</td>
<td>7.7</td>
<td>6.8</td>
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</tr>
<tr>
<td>Class II</td>
<td>5.1</td>
<td>1.7</td>
<td>33</td>
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<tr>
<td>Class III</td>
<td>21.6</td>
<td>7.6</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>34.4</strong></td>
<td><strong>16.1</strong></td>
<td><strong>47</strong></td>
</tr>
</tbody>
</table>
Road Crossings
Road Crossings

- Sediment delivery generally came from crossing approaches.
- Privately-maintained road behind gates generally delivered little sediment.
- Publicly-maintained roads and roads with public access had higher likelihood of delivering moderate magnitudes of sediment.
Two sites were pulled crossings. Moderate magnitude sediment delivery was the result post-abandonment in-channel erosion.
Watercourse-Adjacent Road Segments
Watercourse-Adjacent Road Segments

- Segments most likely to deliver when they were within 30 feet of watercourse

- Roads with moderate to high magnitudes of sediment delivery were within 5 to 20 feet

- Sediment delivery often unmitigatable
Tractor Crossings and Landings

- All tractor crossings deliver at least a low magnitude of sediment
  - Difficult to return channel to pre-logging condition
  - Delivery limited by general lack of tractor crossing
- Landings generally delivered no sediment due to ample surface cover provided by chipping operations
Why No Sediment Delivery from Clearcuts?
BMPs Effective in Preventing Direct Sediment Delivery from Clearcuts

- Strategic skidding and effective drainage (waterbars) limits runoff production and erosion;
- Contour ripping decreases compaction, increases infiltration, and decreases slope length;
- Surface cover remains relatively high (typically greater than 75%);
- Sediment-laden runoff routed to areas relatively undisturbed by heavy machinery;
- Buffer strips effective at infiltrating runoff and filtering sediment.
Is This An Anomaly?

- Litschert and MacDonald (2009) assessed 180 miles of stream buffer adjacent to timber harvest units, including clearcuts, in Sierra Nevada and Southern Cascades;
- Found only 6 erosion features that delivered to watercourses.
Linkage to Fish Habitat

- Clearcuts not causing observable negative impacts to fisheries habitat

- Roads may be causing chronic sedimentation
  - Further study and monitoring needed
Assessment Limitations

• Unable to look at indirect impacts of clearcutting:
  – Clearcutting can increase peak-flow magnitude and duration, potentially resulting in:
    • Increases in suspended sediment and turbidity
    • Channel changes – increased bank erosion and/or gully erosion
Assessment Limitations

• Depends on forensic evidence available in field:
  – Erosion features can be transient
  – Erosion features can be modified by subsequent management
  – Assessment area not subject to stressing storm events during recent harvest activity
    • Time frame coincides with turbidity data collected by BCA
Recommendation #1

• Maintain current emphasis on field review of road crossings, watercourse-adjacent road segments, tractor crossings, landings, and management activities in the WLPZ;

• More emphasis on interagency completion inspections to evaluate adequacy and effectiveness of road-related BMPs.
Recommendation #2

- Encourage landowners in the watershed to develop road management plans for the roads on their property and/or roads they control.

- Encourage development of a watershed-wide road inventory to identify and prioritize the treatment of road-related sediment sources.
Recommendation #3

• Focus on the hydrological disconnection of privately-maintained and publicly-maintained roads

• Training that highlights how to strategically place waterbreaks (rolling dips) to minimize sediment delivery

• Consider access limitations on sensitive road segments during the rainy season to limit damage of erosion control facilities
Recommendation #4

• Evaluate the need to treat road surfaces that drain to watercourses
• Focus treatment on roads most likely to deliver sediment
  – Crossing approaches that cannot be disconnected
  – Roads within $\approx$ 30-50 feet of stream
Recommendation #5

• Road managers should evaluate the need to abandon and/or relocate watercourse-adjacent roads
  – Target roads within 30 to 50 feet of watercourses
Recommendation #6

• Support passage of a comprehensive “Road Rules Package” by the Board of Forestry and Fire Protection.
  – Draft version requires implementation of Recommendations 2 and 3 of this report
Recommendation #7

• Coordinate with counties to develop programs that focus on fish-friendly BMP implementation for county road systems

• Central Valley Water Board will explore regulatory mechanisms to help achieve water quality objectives on county roads
Recommendation #8

• Provide a road and road crossing BMP component for Licensed Timber Operator (LTO) training
Recommendation #9

- Encourage outreach workshops for LTOs, local landowners, and county public works supervisors and equipment operators to inform them of state-of-the-art-road-related-BMPs
Recommendation #10

• Engage in follow-up study to relate results of the assessment to water column data (turbidity) and in-channel physical habitat characteristics.
  – Follow-up study should also address the potential for timber harvest associated peak-flow induced increases to suspended sediment, turbidity, bedload transport, and/or channel alterations.
Conclusions (1)

- No significant direct water quality impacts related specifically to harvest within clearcuts units

- Most sediment delivery comes from road crossings and watercourse-adjacent road segments
Conclusions (2)

• Violations of Forest Practice Rules occurred but generally rare and appeared to be of relatively minor significance at scales relevant to salmonids

• Did not assess indirect water quality impacts from clearcuts
  – Water quality impacts due to logging-induced changes in hydrology remains an open question in young volcanic terranes such as the Battle Creek watershed
Questions?

(http://www.battle-creek.net/)
Turbidity (NTUs)

- Median
- 25%-75%
- Non-Outlier Range
- Outliers
- Extremes

Threshold for
Visible
Turbidity

Threshold for Stressing
Salmon